HENEX ELECTRONICS

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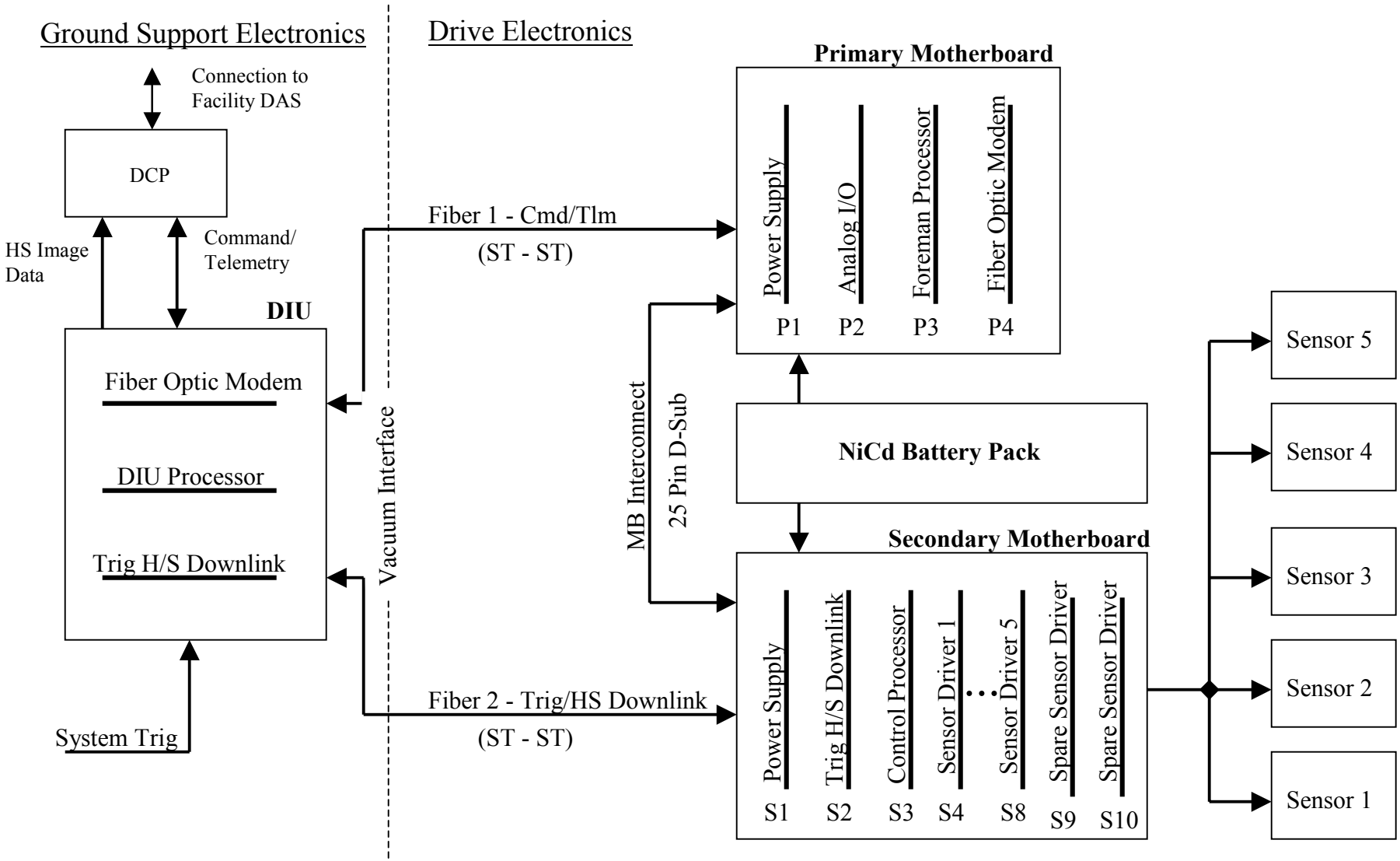
Electronics System Overview



- Drive Electronics Crate
  - Motherboard-based design
    - Polarized connectors
    - Minimizes internal wiring
  - Utilizes heritage designs where possible
    - Power Supply, Analog, Foreman, F/O Modem
  - Generic sensor-slot design
    - Custom CMOS detector interface
    - Easily expandable to other custom sensor boards without hardware modification
      - Design can handle up to 15 sensor boards per crate
      - Each sensor card contains a personality id for automatic registration
      - Electronics crates can be daisy-chained if more sensor boards are required
      - HENEX crate has space for 7 sensor boards (5 HENEX sensors plus 2 spares)
- Ground Support Electronics
  - Desktop Computer based platform
    - Communicates with the Facility DAS through Front End Processor (FEP)
    - Controls Commanding/Telemetry
    - Displays and stores downloaded image data
    - Utilizes heritage DIU Processor and F/O Modem designs
    - High-speed data transfer
    - GUI for Monitoring and Control (WEB-Browser enabled)

NiCd Battery Pack

- Heritage design
  - Heritage NiCd battery cell technology (various satellites, HXS)
  - Heritage (HXS) pressure cell design prevents any outgassing should the battery cells suffer a catastrophic failure and overheat
  - Mechanical analysis shows the pressure cell is designed with factor of 28 margin
- Instrument is designed to run entirely from the internal battery pack
  - Fiber optic connections through the chassis allow a Faraday cage around the entire instrument electronics and sensors
  - Severely reduces EMP/EMI susceptibility
  - Proven design strategy (HXS)
- At continuous full-power, battery will last ~12-16 hours
- Normal shot cycle will have the instrument at standby power for significant durations
  - 2 Hour shot cycle (Full power for 15 min per cycle) : Battery will last ~74 hours with 20% margin
  - 6 Hour shot cycle (Full power for 15 min per cycle) : Battery will last ~116 hours with 20% margin

  * These numbers assume a 24Hour/Day operation schedule
- Alternate configurations are possible as instrument upgrades which will yield significantly longer battery lifetimes.
  - Increase battery capacity (alternate configurations, different battery cell technology)
  - Remote power down
  - Remote optical trickle charge

Control Points/Monitoring Functions

Major Control Points

- Power state
  - Standby : minimal control elements powered
  - Medium : all control elements powered, analog system at low power
  - Full : everything operating
- Time (relative to T0) of start of integration
  - Coarse control/fine control
- Time duration of sensor integration
  - Fine control
- High/Low resolution sensor readout
- Dynamic range for sensor data
  - 12bit sampling depth
- Telemetry reporting rate
- Software force trigger pulse
- Optical power gain control
  - AGC Fiber Optic Modem
  - Digital gain control on High Speed/Trigger Fiber Optic

Monitoring Functions

- Processor samples 24 channels at 8bit resolution
- Worst case sample rate is 0.25 Hz
- Analog telemetry is reported to the DCP with digital telemetry at approximately 0.5 Hz

Specific Drive Electronics Monitored Analog Data

- Battery Voltage
- Primary/Secondary +5V and +3.3V
- Primary +12V
- Primary/Secondary Power Supply Temperatures
  - 2 Sensors for +5V Supplies
  - 1 Sensor for +3.3V Supplies
- Primary/Secondary Battery Current
- Primary Controller Temperatures (2)
- Secondary Controller Temperatures (2)
- Fiber Optic Modem RSSI
- High Speed Data/Trigger Fiber Optic RSSI
- Six Spare Channels

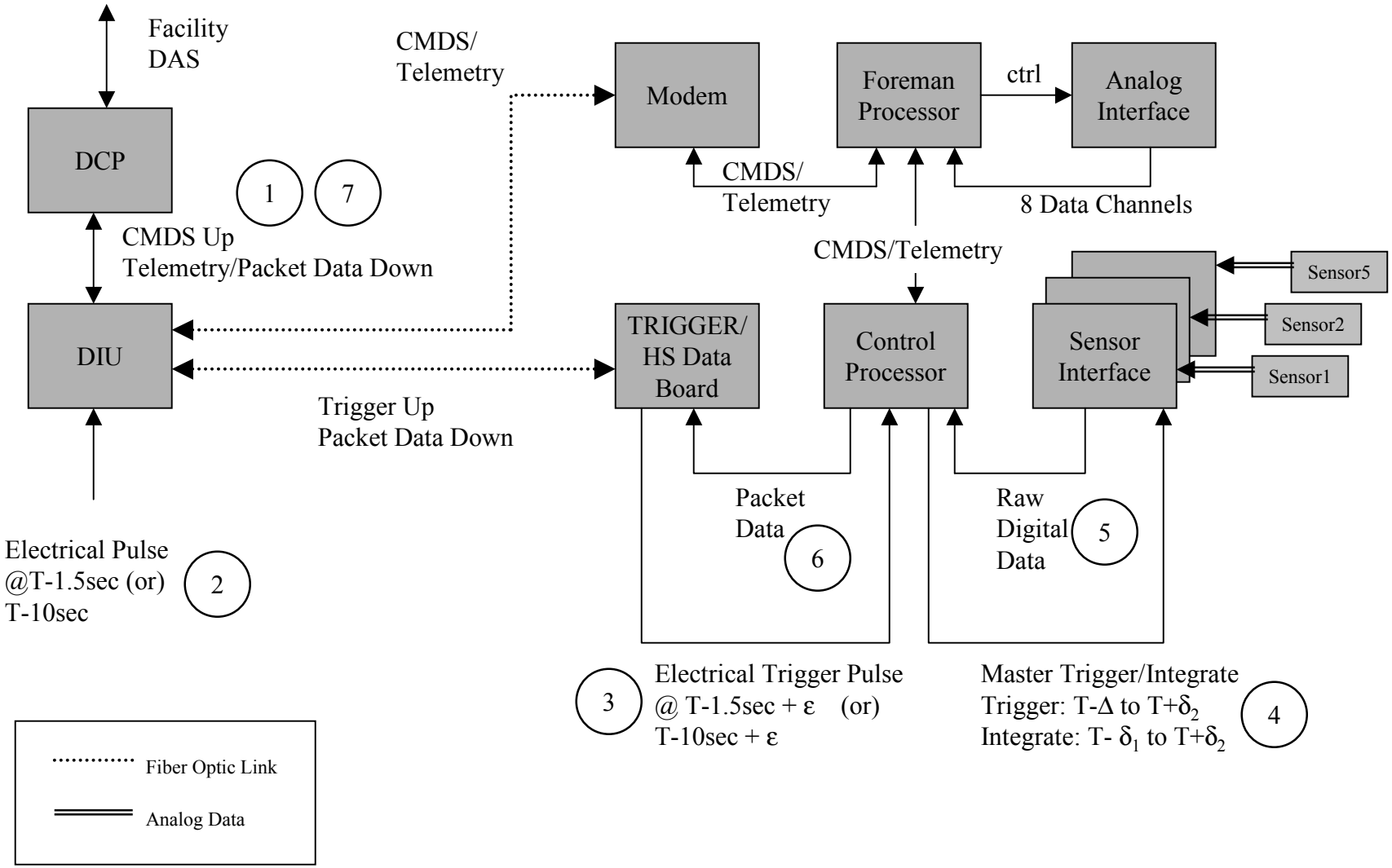
Current Telemetry List (Monitor Points)

Mnemonic	Description	Units
MN_DIUTIME	DIU Processor Time (since power-on)	seconds
MN_DIUUPDTIME	Last DIU communication	wall-time
MN_DIUERRPACKETS	Number of failed DIU communication packets	dimensionless
MN_DIUCOMMANDS	Number of DIU Commands executed	dimensionless
MN_DIURX	Number of DIU packets received (by DIU)	dimensionless
MN_DIUTX	Number of Packets transmitted by DIU	dimensionless
MN_DIUFAILCMDS	Number of DIU commands which failed execution	dimensionless
MN_DIUSTATE	Current DIU state	dimensionless
MN_DIUTRIGSTATE	Current DIU trigger state	dimensionless
MN_DIUMODEMRSSI	DIU modem RSSI value	uWatt
MN_DIUHSRSSI	DIU High Speed Data link RSSI value	uWatt
MN_DIUFIBERMODE	Trigger or High-Speed data mode	dimensionless
MN_DIUTLMRATE	DIU telemetry report rate	seconds
MN_FMNUPDTIME	Last Foreman Communication	wall-time
MN_FMNTIME	Foreman Processor time (since power-on)	seconds
MN_FMNRXPKT	Number of packets received by foreman	dimensionless
MN_FMNTXPKT	Number of packets transmitted by foreman	dimensionless
MN_FMNSTATE	Foreman operational state	dimensionless
MN_FMNSWVERSION	Foreman Software Version	dimensionless
MN_FMNCMDS	Number of foreman commands executed	dimensionless
MN_FMNCMDERRS	Number of foreman commnands which failed execution	dimensionless
MN_FMNPRI5V	Primary +5V supply voltage	volts
MN_FMNPRI5VT1	Primary +5V Temperature sensor1	degrees C
MN_FMNPRI5VT2	Primary +5V Temperature sensor2	degrees C
MN_FMNPRI3V	Primary +3.3V suply voltage	volts
MN_FMNPRI3VT1	Primary +3.3V Temperature sensor	degrees C
MN_FMNPRI12V	Primary +12V supply voltage	volts
MN_FMNPRI12VT1	Primary +12V temperature sensor	degrees C
MN_FMNSEC5V	Secondary +5V supply voltage	volts
MN_FMNSEC5VT1	Secondary +5V Temperature sensor1	degrees C
MN_FMNSEC5VT2	Secondary +5V Temperature sensor2	degrees C
MN_FMNSEC3V	Secondary +3.3V suply voltage	volts
MN_FMNSEC3VT1	Secondary +3.3V Temperatyre sensor	degrees C
MN_FMNSEC12VT1	Secondary +12V temperature sensor	volts
MN_FMNT1	Foreman Temperature Sensor 1	degrees C
MN_FMNT2	Foreman Temperature Sensor 2	degrees C
MN_FMNCTLT1	Control Temperature Sensor 1	degrees C
MN_FMNCTLT2	Control Temperature Sensor 2	degrees C
MN_FMNBATV	Battery Voltage	volts
MN_FMNPBATI	Primary battery current	amps
MN_FMNSBATI	Secondary Battery current	amps
MN_FMNMODEMRSSI	Foreman F/O Modem RSSI	uWatt
MN_FMNTRIGRSSI	Foreman Trigger RSSI	uWatt
MN_FMNSPARE1	Spare Measurement 1	volts
MN_FMNSPARE2	Spare Measurement 2	volts
MN_FMNSPARE3	Spare Measurement 3	volts
MN_FMNSPARE4	Spare Measurement 4	volts
MN_FMNSPARE5	Spare Measurement 5	volts
MN_FMNSPARE6	Spare Measurement 6	volts
MN_CTLUPDTIME	Last Control processor communication time	wall-time
MN_CTLSWVERSION	Control software version	dimensionless
MN_CTLTIME	Control Processor Time (since power on)	seconds
MN_CTLGAVERSION	Control Hardware Version	dimensionless
MN_CTLNCMDS	Number of control commands executed	dimensionless
MN_CTLERRCMDS	Number of control commnands which failed execution	dimensionless
MN_CTLRXPKT	Number of packets received by control	dimensionless
MN_CTLTXPKT	Number of packets transmitted by control	dimensionless
MN_CTLHSTXPKT	Number of high-speed data packets transmitted by control	dimensionless
MN_CTLBRDCON	Indicator of which sensor boards are populated	bit-field
MN_CTLBRDTYPE	Type of each connected board	dimensionless
MN_CTLTRIGDLY	Delay from Trigger pulse of sensor clear signal	milliseconds
MN_CTLINTGDLY	Delay from Trigger pulse of sensor start integrate signal	milliseconds
MN_CTLINTGDUR	Integration duration	milliseconds
MN_CTLGATRIGDLY	H/W Readback of sensor clear delay	milliseconds
MN_CTLGAINTGDLY	H/W Readback of sensor start integrate delay	milliseconds
MN_CTLGAINTGDUR	H/W Readback of integration duration	milliseconds
MN_CTLTRIGSTATUS	Control Trigger State	dimensionless
MN_DCPLUPDTIME	DCP telemetry update time	wall-time
MN_DCPLTIME	DCP time	wall-time
MN_DCPLDIURX	Number of DIU packets received by DCP	dimensionless
MN_DCPLDIUTX	Number of DIU packets transmitted by DCP	dimensionless
MN_DCPLHSDRX	Number of High-Speed data packets received by DCP	dimensionless
MN_DCPLFMNRX	Number of foreman packets received by DCP	dimensionless
MN_DCPLFMNTX	Number of foreman packets transmitted by DCP	dimensionless
MN_DCPLIMGREG	Current Image registration Numbers	dimensionless
MN_DCPLIMGCOMP	Current Image Download completion	percent
MN_DCPLREFREG	Current reference Image registration Numbers	dimensionless
MN_DCPLREFCOMP	Current reference Image Download completion	percent

Sensor Driver Board

- Hardware readout of sensor data and storage in SRAM
  - All image data is lost on power-down
- Dedicated board for each sensor
  - Sensors are read-out in parallel, minimizing dark current build-up
- Sensors are sampled with 12bit precision
- Digitally Programmable Gain
  - Three gain stages
  - Allows adjustment of the dynamic range on a per-shot basis
  - Data is normalized enabling absolute comparisons across all gain levels
- Digitally Programmable Offset available as an instrument upgrade
- Sensor board calibration available as an instrument upgrade

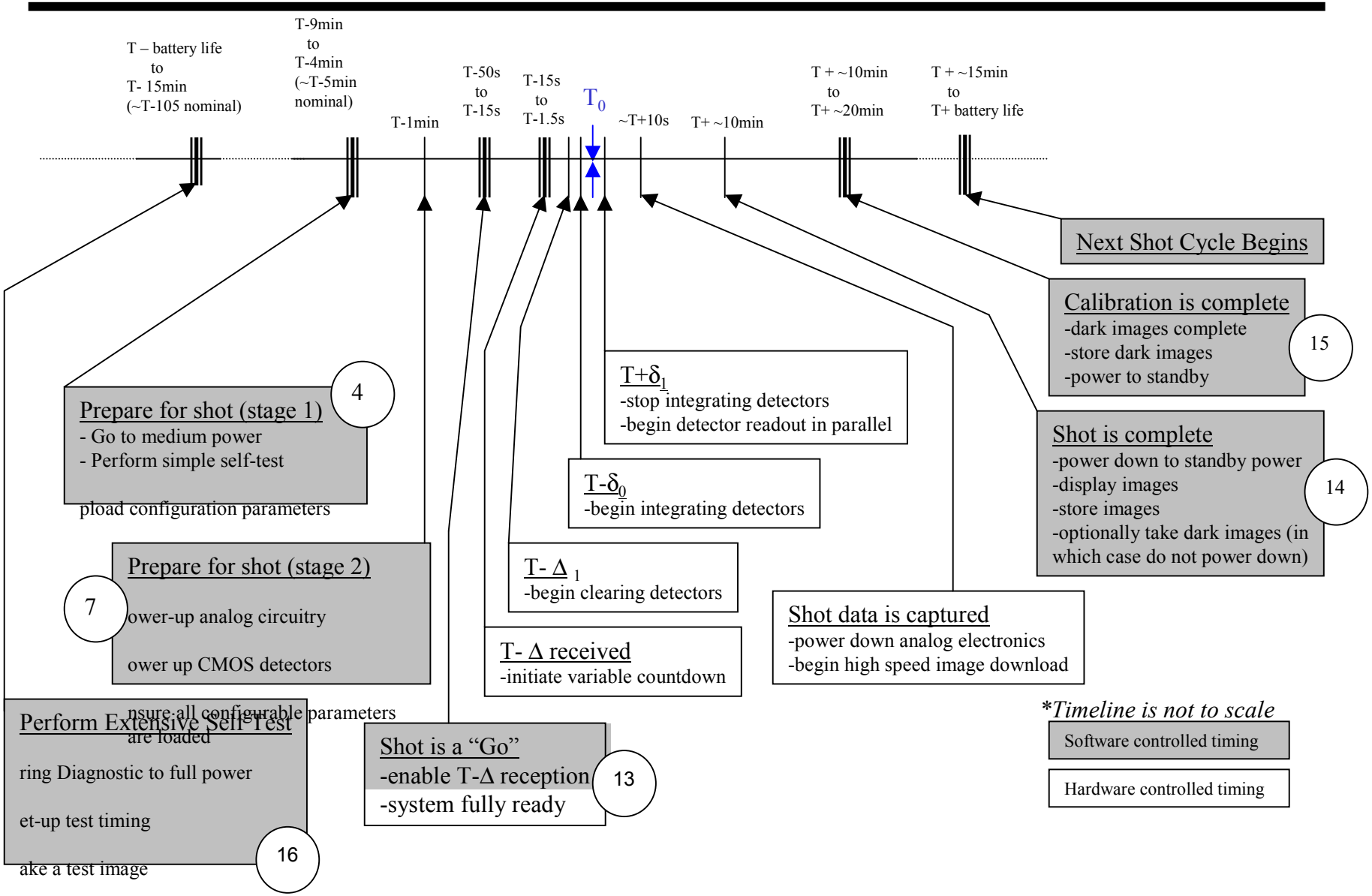
Overall Data Flow



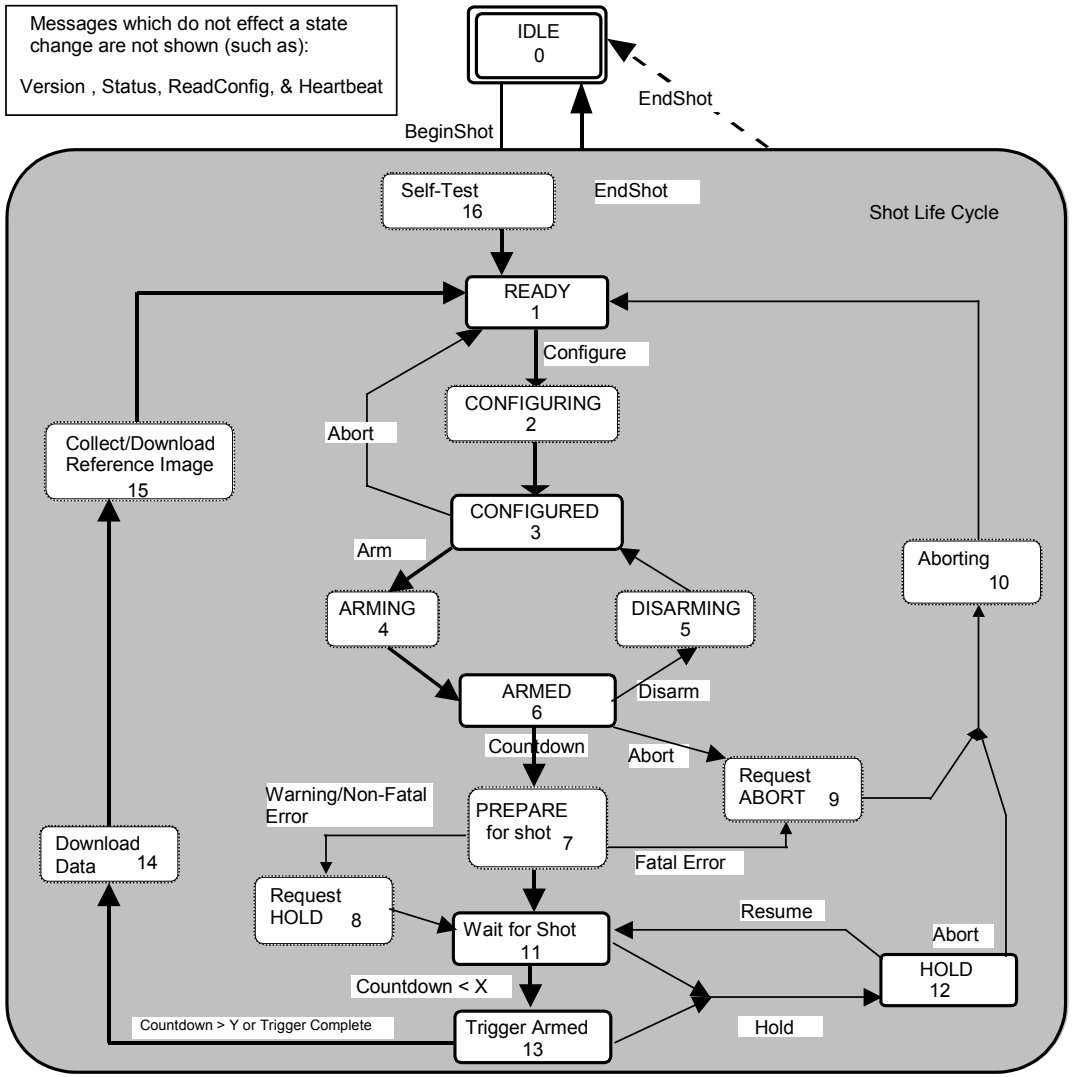
Data Flow Description

1) Normal telemetry collection occurs in the background. Approximately 5 minutes prior to the shot, the foreman is instructed to power-up the secondary electronics. Any gain selections and control parameters are forwarded to the instrument at this time.
2) Immediately proximal to the shot (at a facility-dependent time) an electrical trigger signal is received from the facility DAS, and is forwarded to the instrument via fiber.
3) The timing pulse is received by the instrument. The control processor executes a configurable delay and then issues a Master Trigger and a configurable Master Integrate signal to the sensor boards.
4) The sensor boards execute a configurable delay, clear the sensor and integrate the sensor. Immediately following integration, each sensor's control board autonomously reads the data from the sensor into local SRAM.
5/6) When all data has been read from the sensors, the control processor indicates that data is available for download. Under command from the DCP, the data is read from the sensor control boards and downloaded via high-speed, error-checked data link to the support equipment.
7) When all data is successfully downloaded, the foreman is instructed to power-down the secondary electronics. (NOTE: prior to power-down a dark image may be collected)

Instrument Timeline



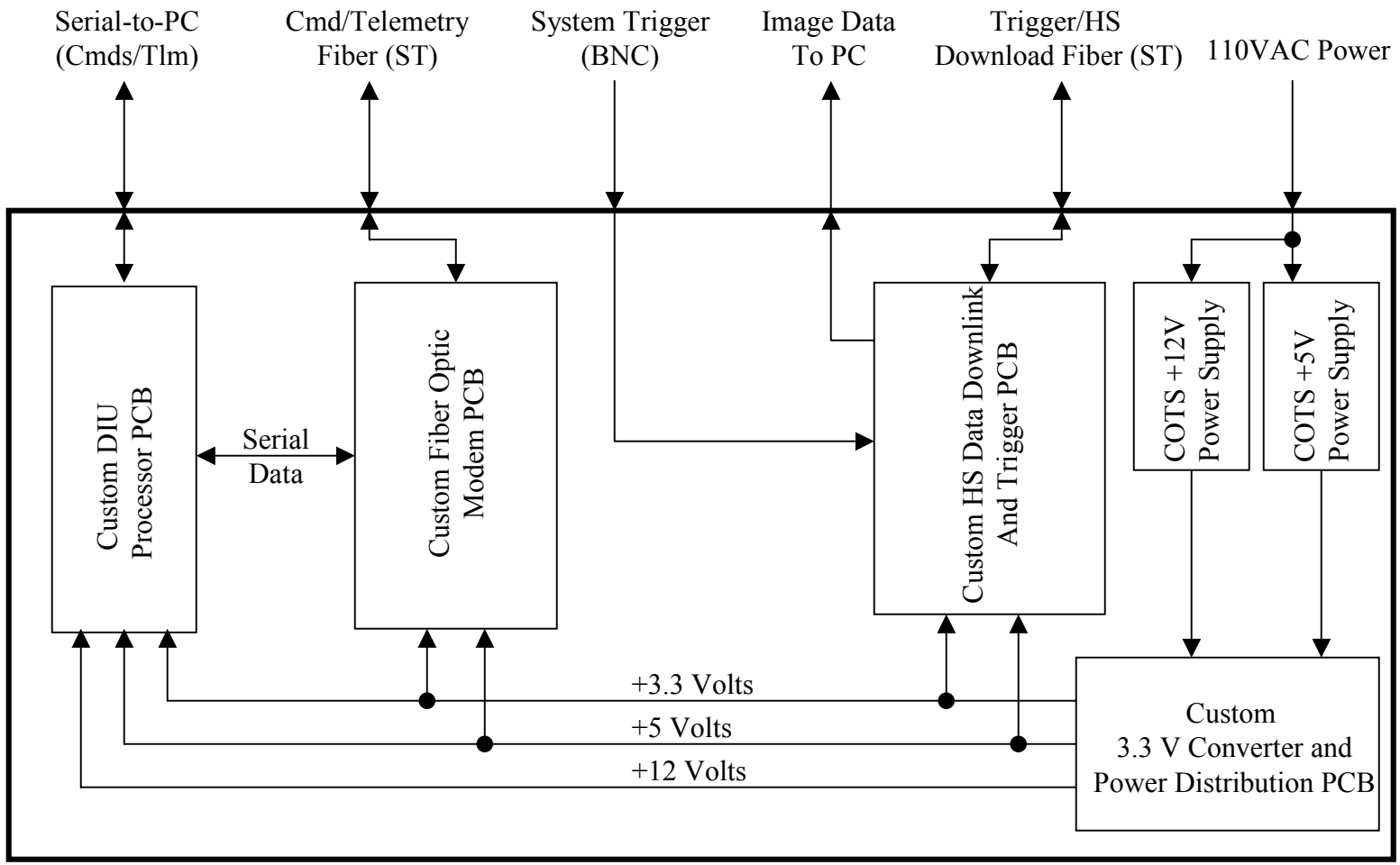
DCP State Diagram



There will exist an internal state mapping from local DCP states to the global NIF state designators (0-6). Additional local DCP state information will be provided in the user-specified area of the state descriptor.

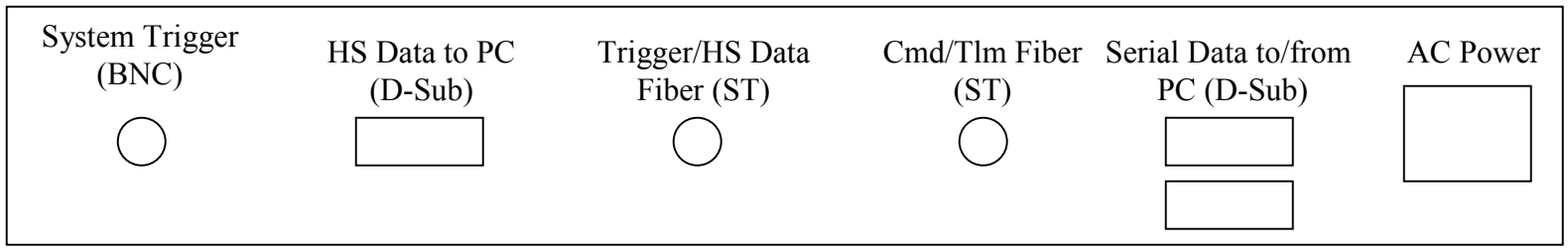
Ground Support Electronics

DIU GSE Assembly

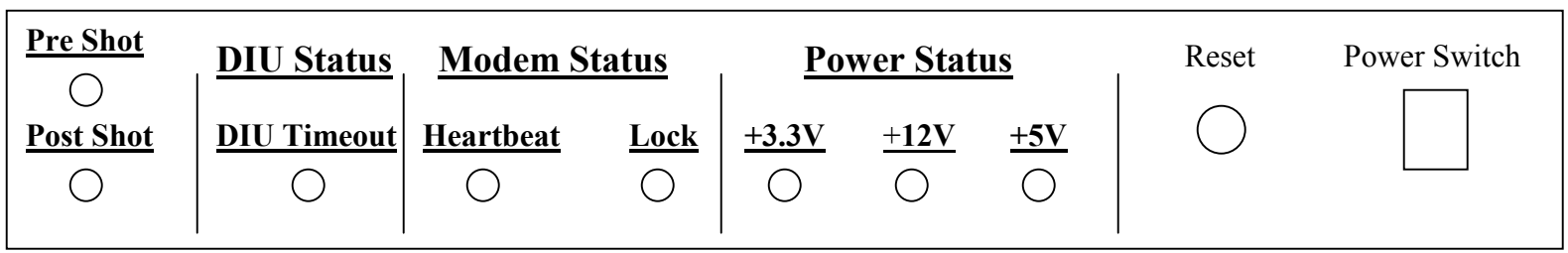


Box Configuration

Rear Panel



Front Panel



Proto-Typing Results

- Built and Tested all boards
- Software/Gatearrays complete and Beta Testing
- Able to control and monitor all specified points
  - Primary and Secondary Voltages and Currents
  - Temperatures in Centigrade
- Mechanical Prototypes fit well
- Heatsink on Powersupply functions better than expected
- Primary-side power consumption is in expected range (~1watt)

- Built and Tested all boards
  - Control Processor
    - Software/Gatearrays 90% complete
  - Trigger/High-Speed Data
    - Gatearray complete and beta testing
    - Validated RSSI and Transmit Power circuitry
  - Motherboard
    - Functioning well – a few issues requiring re-fabrication
  - CMOS Sensor Board
    - Gatearray 80% complete
    - Analog section functioning – need to finalize TBD gain factors
    - Demonstrated ability to capture and downlink digitized data
- Mechanical Prototypes fit well
- Power consumption is in expected range
  - ~1Watt for secondary control/trigger boards
  - ~2Watts per sensor board

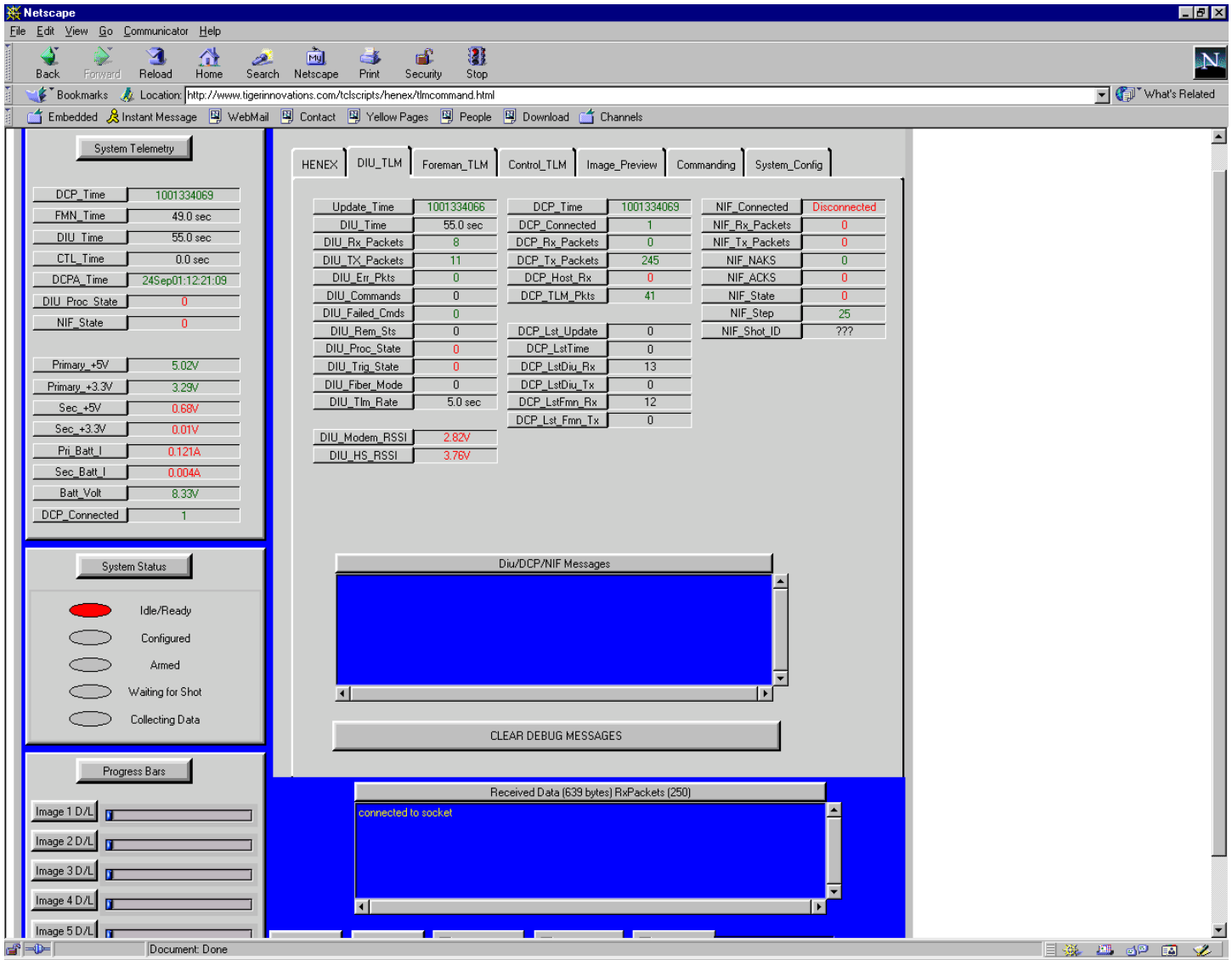
- System is built and tested
  - DCP
    - Linux computer
    - Control software is 90% complete
    - GUI is 90% complete
  - DIU
    - Control processor
      - Software/Gatearray complete and beta testing
    - Trigger/High-Speed Data
      - Gatarray complete and beta testing
      - RSSI/Transmit circuitry validated
    - Integrated and functioning with DCP

Control System (DCP)

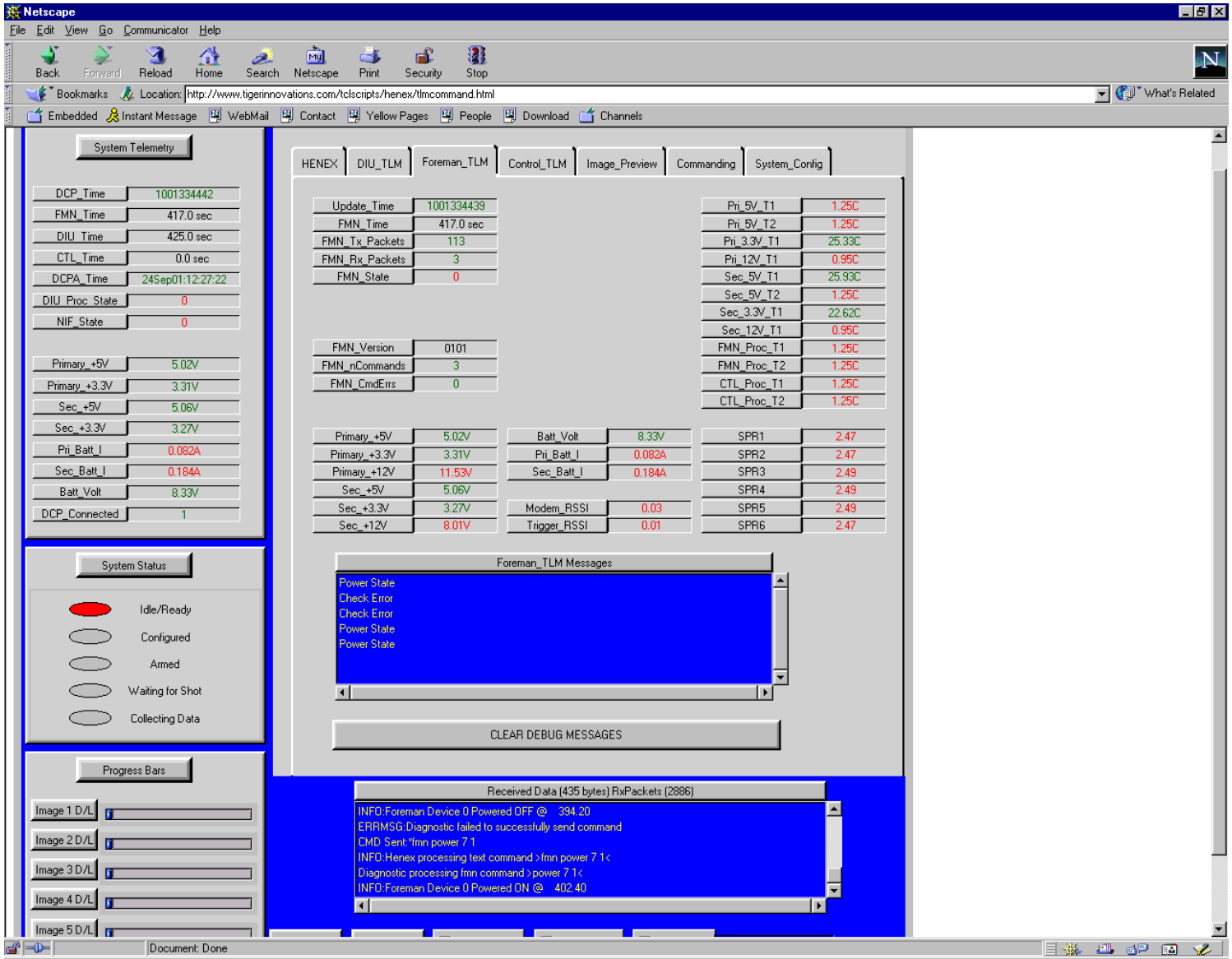
- Re-designed DCP to work with proposed NIF DAS
- Current control system will work at LLE with Omega system since NIF specification is still in flux
- Upgrade to work with finalized NIF DAS will occur later
  - Modular design will allow replacement of the facility library with NIF facility interface
  - Will allow easy migration path from LLE to NIF
- Graphical Interface to Control System
  - Allows monitoring of system status
  - User can send commands
  - Web-Browser access

Instrument Control and Monitoring
(Graphical User Interface)

- Web-Based GUI used to control/monitor the instrument
  - DCP operates a telemetry/control server allowing many different connections
  - Most connections will only be telemetry monitoring stations
  - Access to control and/or monitoring web-pages is password controlled
- Telemetry points are flagged as Red/Yellow/Green based on error limits for the individual points
- Paged-Display
  - Telemetry is grouped into functional items
  - "Quick-Look" at critical telemetry points is always available
  - Single page with all crucial instrument health data is planned
- Image Data
  - Binned images are displayed as they are downloaded for instant "warm-and-fuzzy" of image-capture success
  - Progress bars show image download progress (from instrument to GSE)
- State of the Facility interface is easily ascertained
- Debug/Informational messages are displayed in scroll-boxes


Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Netscape Print Security Stop
Bookmarks Location: http://www.tigerinnovations.com/tclscripts/henex/tlmcommand.html
What's Related
Embedded Instant Message WebMail Contact Yellow Pages People Download Channels
System Telemetry
DCP_Time 1001334069
FMN_Time 49.0 sec
DIU_Time 55.0 sec
CTL_Time 0.0 sec
DCPA_Time 24Sep01:12:21:09
DIU_Proc_State 0
NIF_State 0
Primary_+5V 5.02V
Primary_+3.3V 3.29V
Sec_+5V 0.68V
Sec_+3.3V 0.01V
Pri_Batt_I 0.121A
Sec_Batt_I 0.004A
Batt_Volt 8.33V
DCP_Connected 1
System Status
Idle/Ready
Configured
Armed
Waiting for Shot
Collecting Data
Progress Bars
Image 1 D/L
Image 2 D/L
Image 3 D/L
Image 4 D/L
Image 5 D/L
HENEX DIU_TLM Foreman_TLM Control_TLM Image_Preview Commanding System_Config
Update_Time 1001334066
DIU_Time 55.0 sec
DIU_Rx_Packets 8
DIU_TX_Packets 11
DIU_Err_Pkts 0
DIU_Commands 0
DIU_Failed_Cmds 0
DIU_Rem_Sts 0
DIU_Proc_State 0
DIU_Trig_State 0
DIU_Fiber_Mode 0
DIU_Tlm_Rate 5.0 sec
DIU_Modem_RSSI 2.82V
DIU_HS_RSSI 3.76V
DCP_Time 1001334069
DCP_Connected 1
DCP_Rx_Packets 0
DCP_Tx_Packets 245
DCP_Host_Rx 0
DCP_TLM_Pkts 41
DCP_Lst_Update 0
DCP_LstTime 0
DCP_LstDiu_Rx 13
DCP_LstDiu_Tx 0
DCP_LstFmn_Rx 12
DCP_Lst_Fmn_Tx 0
NIF_Connected Disconnected
NIF_Rx_Packets 0
NIF_Tx_Packets 0
NIF_NAKS 0
NIF_ACKS 0
NIF_State 0
NIF_Step 25
NIF_Shot_ID ???
Diu/DCP/NIF Messages
CLEAR DEBUG MESSAGES
Received Data (639 bytes) RxPackets (250)
connected to socket
Document: Done

GUI – Foreman Processor Page



GUI – Control Processor Page